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Seino

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(54) **IN-VEHICLE NAVIGATION IN COLLABORATION WITH A SERVER**

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G01C 21/26 (2006.01)

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CPC ***G01C 21/3679*** (2013.01); ***G01C 21/3469*** (2013.01); *G01C 21/26* (2013.01); *G01C 21/36* (2013.01); *Y02T 90/168* (2013.01); *Y04S 30/12* (2013.01)

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USPC 701/22, 410
See application file for complete search history.

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Primary Examiner — James Trammell
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(57) **ABSTRACT**

An in-vehicle navigation apparatus to support sharing of electric vehicle charging point information such that other electric vehicles can use a charging point where its own electric vehicle is charged. If the in-vehicle navigation apparatus determines that a current position is a charging point on the basis of charge information about an electric vehicle, the navigation apparatus determines whether the charging point has public availability by referring to facility information, such as facility positions in map data stored in a map data storage unit. The in-vehicle navigation apparatus may transmit charging points having public availability to a server apparatus and not transmit the charging points having no public availability to the server apparatus. Vehicles may download charging points uploaded by other vehicles.

12 Claims, 7 Drawing Sheets

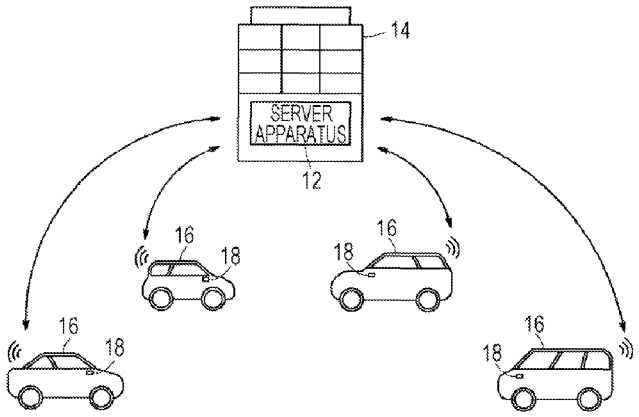

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FIG. 1

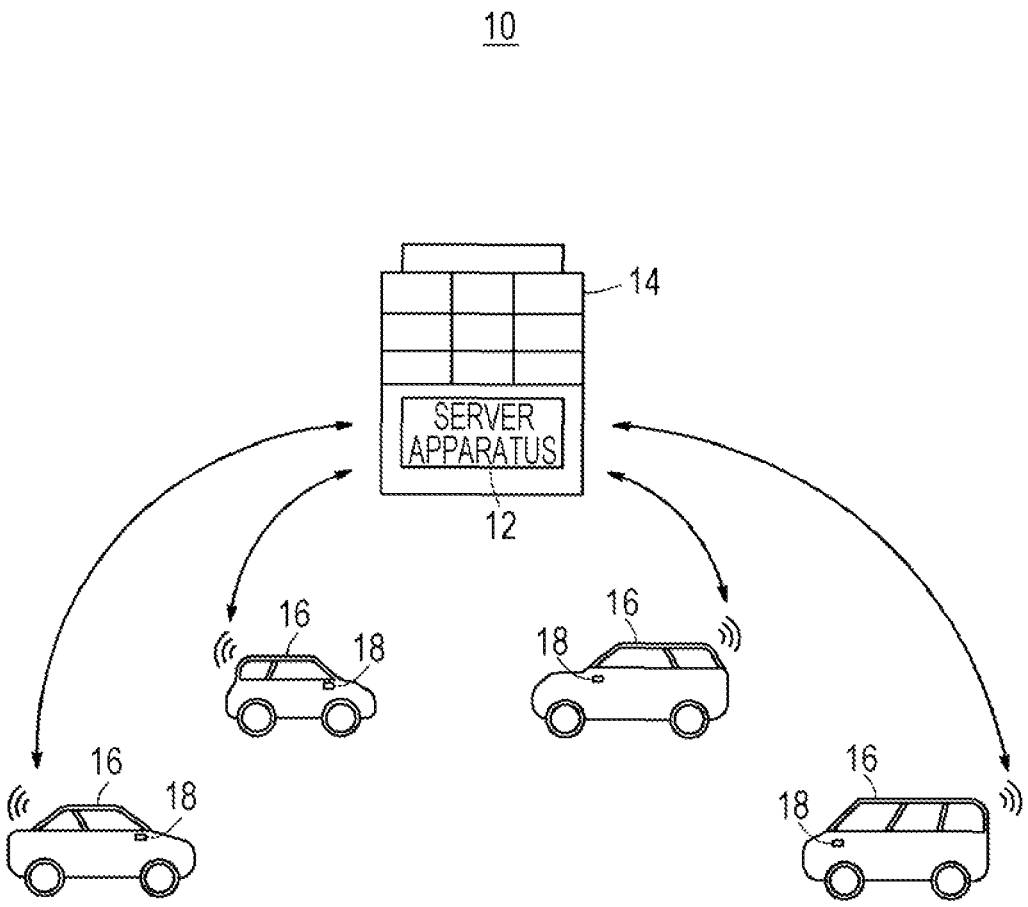


FIG. 2

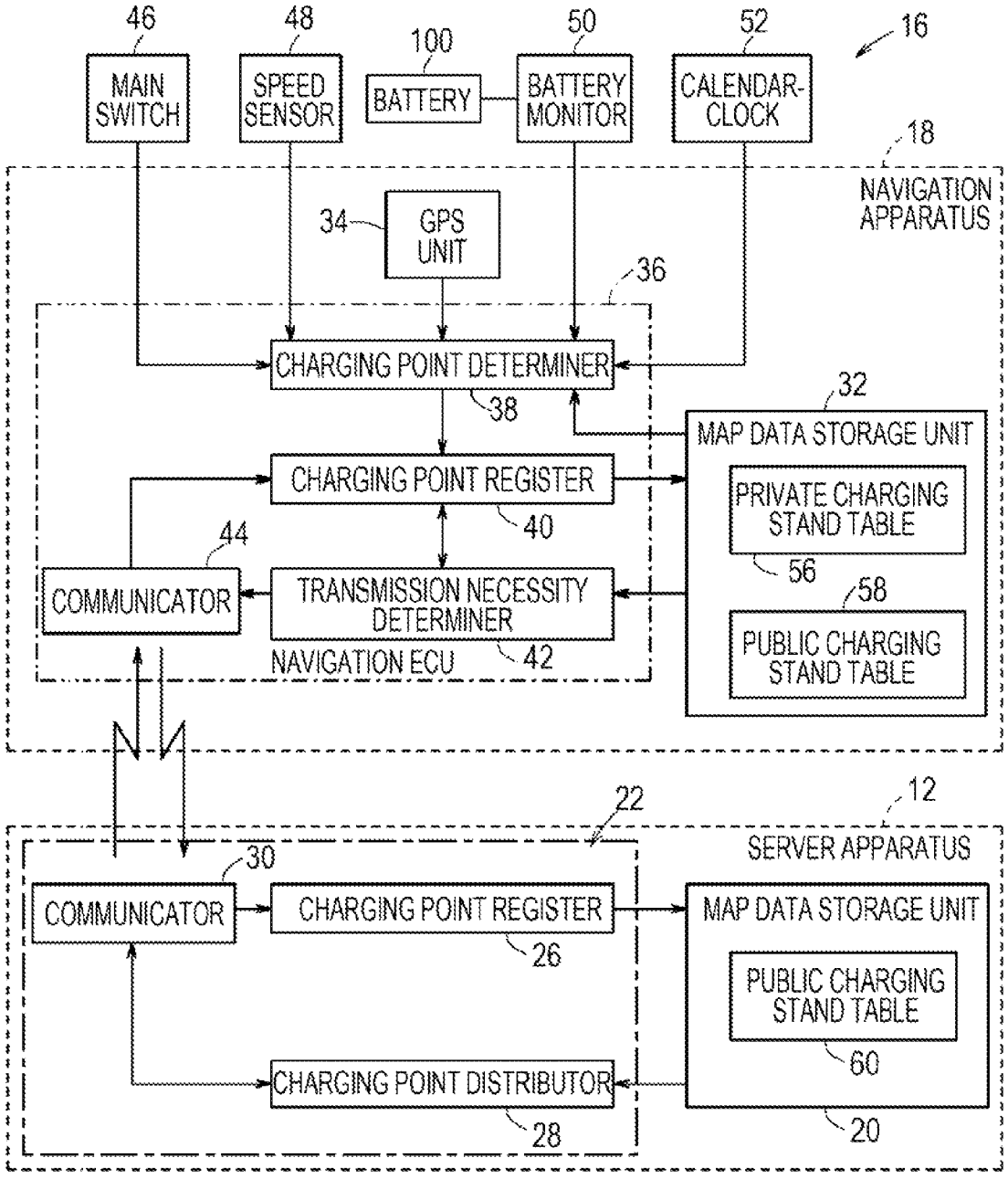

10
46
MAIN SWITCH
48
SPEED SENSOR
100
BATTERY
50
BATTERY MONITOR
52
CALENDAR-CLOCK
16
18
NAVIGATION APPARATUS
34
GPS UNIT
36
CHARGING POINT DETERMINER
38
32
MAP DATA STORAGE UNIT
CHARGING POINT REGISTER
40
PRIVATE CHARGING STAND TABLE
56
58
44
COMMUNICATOR
TRANSMISSION NECESSITY DETERMINER
42
PUBLIC CHARGING STAND TABLE
NAVIGATION ECU
22
12
SERVER APPARATUS
30
COMMUNICATOR
CHARGING POINT REGISTER
26
MAP DATA STORAGE UNIT
PUBLIC CHARGING STAND TABLE
60
CHARGING POINT DISTRIBUTOR
28
20

FIG. 3

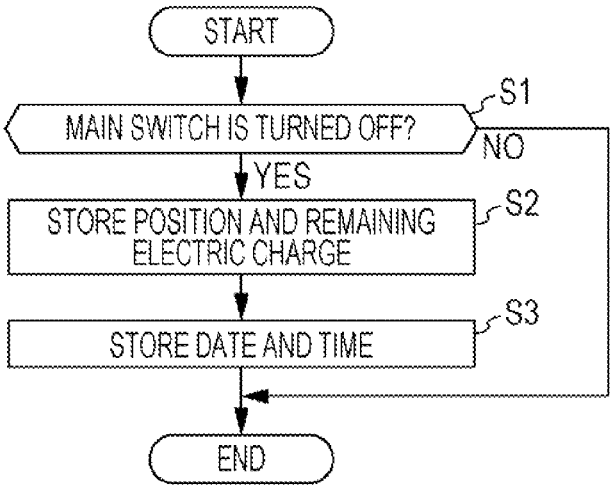

START
MAIN SWITCH IS TURNED OFF?
S1
NO
YES
STORE POSITION AND REMAINING ELECTRIC CHARGE
S2
STORE DATE AND TIME
S3
END

FIG. 4

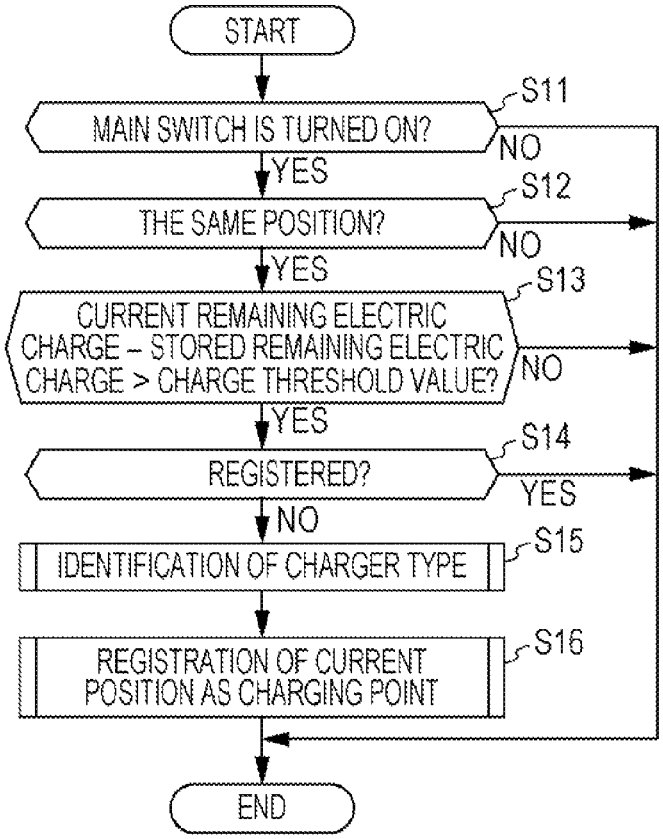

START
MAIN SWITCH IS TURNED ON?
S11
NO
YES
THE SAME POSITION?
S12
NO
YES
CURRENT REMAINING ELECTRIC CHARGE – STORED REMAINING ELECTRIC CHARGE > CHARGE THRESHOLD VALUE?
S13
NO
YES
REGISTERED?
S14
YES
NO
IDENTIFICATION OF CHARGER TYPE
S15
REGISTRATION OF CURRENT POSITION AS CHARGING POINT
S16
END

FIG. 5

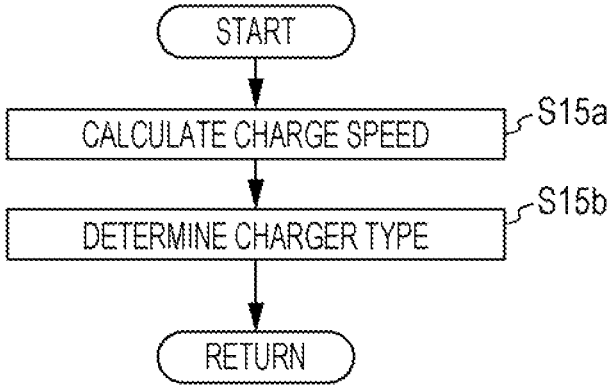

START
CALCULATE CHARGE SPEED
S15a
DETERMINE CHARGER TYPE
S15b
RETURN

FIG. 6

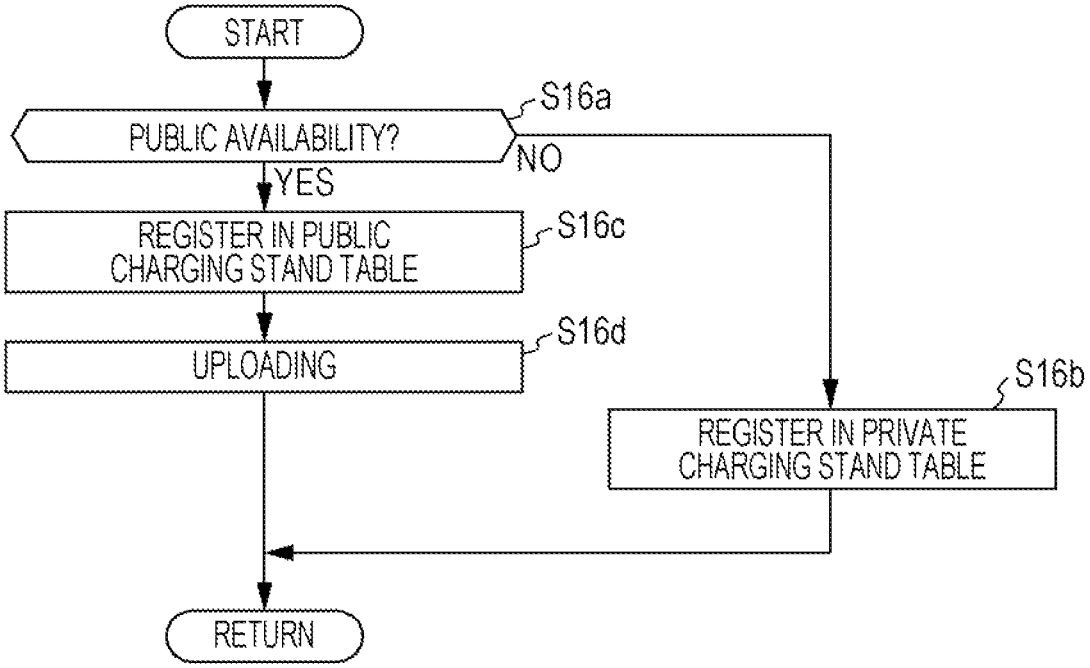

START
PUBLIC AVAILABILITY?
S16a
NO
YES
REGISTER IN PUBLIC CHARGING STAND TABLE
S16c
UPLOADING
S16d
REGISTER IN PRIVATE CHARGING STAND TABLE
S16b
RETURN

FIG. 7

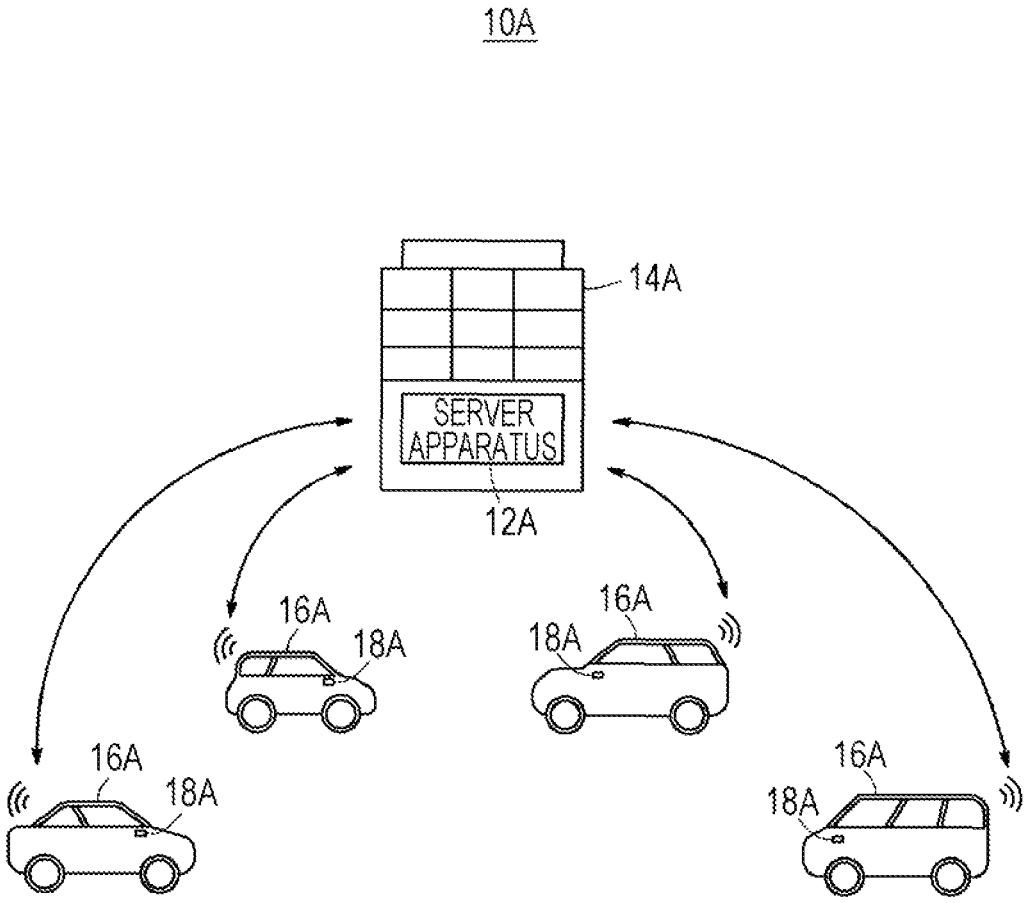


FIG. 8

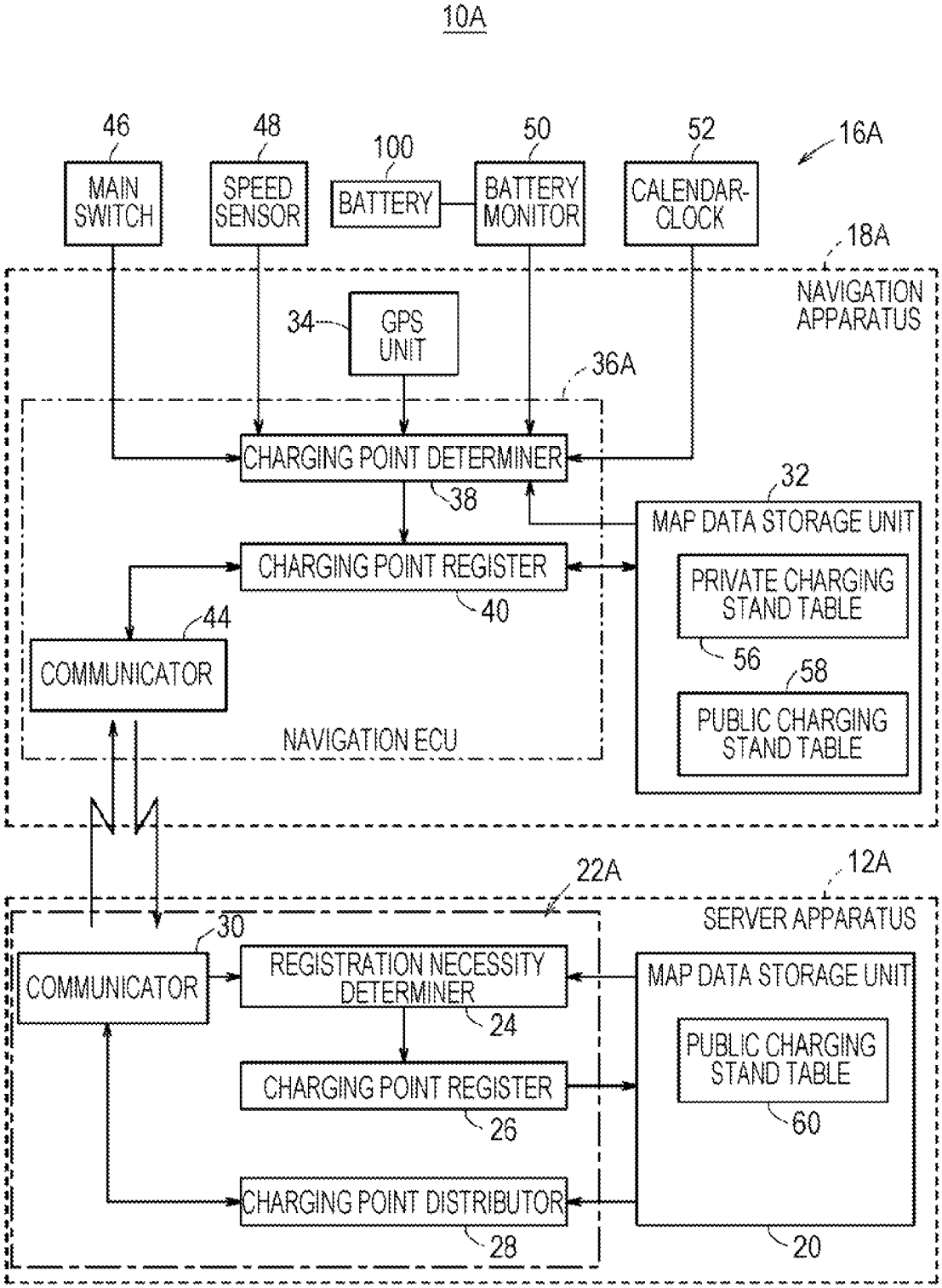

10A
46
MAIN SWITCH
48
SPEED SENSOR
100
BATTERY
50
BATTERY MONITOR
52
CALENDAR-CLOCK
16A
18A
NAVIGATION APPARATUS
34
GPS UNIT
36A
CHARGING POINT DETERMINER
38
32
MAP DATA STORAGE UNIT
CHARGING POINT REGISTER
40
PRIVATE CHARGING STAND TABLE
56
58
PUBLIC CHARGING STAND TABLE
44
COMMUNICATOR
NAVIGATION ECU
22A
12A
SERVER APPARATUS
30
COMMUNICATOR
REGISTRATION NECESSITY DETERMINER
24
MAP DATA STORAGE UNIT
PUBLIC CHARGING STAND TABLE
60
CHARGING POINT REGISTER
26
CHARGING POINT DISTRIBUTOR
28
20

FIG. 9

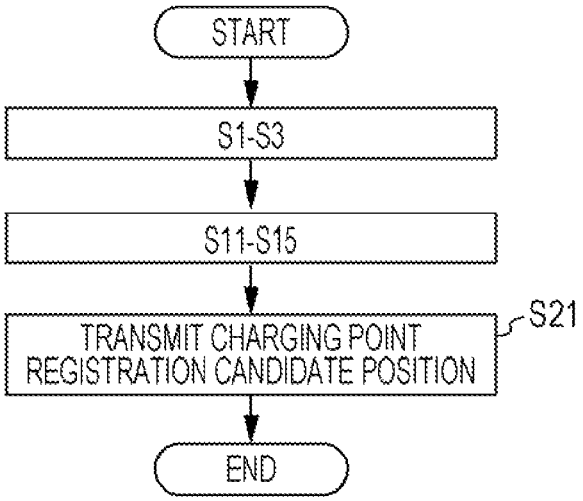
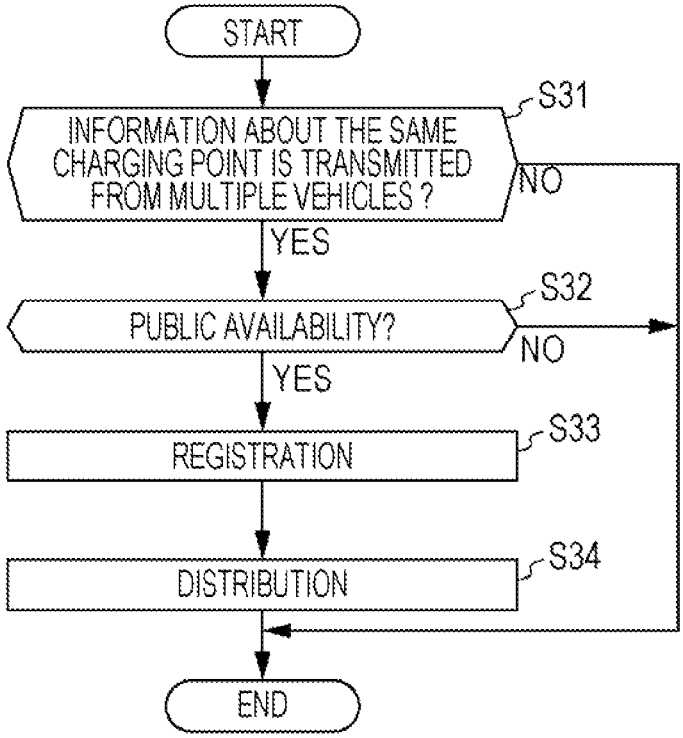

START
S1-S3
S11-S15
TRANSMIT CHARGING POINT REGISTRATION CANDIDATE POSITION
S21
END

FIG. 10


START
INFORMATION ABOUT THE SAME CHARGING POINT IS TRANSMITTED FROM MULTIPLE VEHICLES ?
S31
NO
YES
PUBLIC AVAILABILITY?
S32
NO
YES
REGISTRATION
S33
DISTRIBUTION
S34
END

IN-VEHICLE NAVIGATION IN COLLABORATION WITH A SERVER

CLAIM OF PRIORITY

The present application claims priority under 35 U.S.C. §119 to Japanese Patent Application No. 2010-256532, filed Nov. 17, 2010, entitled "In-vehicle navigation apparatus and server apparatus." The contents of this application are incorporated herein by reference in their entirety.

BACKGROUND

The present disclosure relates to in-vehicle navigation apparatuses that detect the current positions of their own vehicles to instruct drivers of the vehicles of routes (or, also referred to as courses) to destinations and server apparatuses communicating with the in-vehicle navigation apparatuses.

Electric vehicles (EVs) exist that receive a supply of the electric power from batteries to drive with the power from electric motors. In addition, plug-in hybrid vehicles exist that receive primary power from electric motors and receive auxiliary power from engines. For purposes of the subject matter disclosed herein, electric vehicles include, but are not limited to, plug-in hybrid vehicles (PHVs) that receive auxiliary or primary power from engines.

An electric vehicle may be provided with a power plug for charging the vehicle. In such a case, the power plug may be inserted into an outlet of a point where the battery is capable of being charged (which may be referred to as a charging point or charge point), such as a charging stand, in order to charge the battery.

As charging points are being upgraded or newly installed it may be important for drivers of electric vehicles having shorter traveling distances (e.g., on pure electric modes of operation of an electric vehicle in comparison to gasoline-powered vehicles or gasoline hybrid vehicles) to know positional information about the charging points.

A charge point registering apparatus has been disclosed that registers the current position of its own vehicle in a map database of the own vehicle as a charge point when a state of charge (SOC) value at stop is higher than a SOC value at restart by a certain amount.

One point registering apparatus categorizes charging points (e.g., sorts charging points according to charging modes) on the basis of the charging frequency or the charging time at each point where a battery is charged. That apparatus can also register categorized charging points in a map database of its own vehicle.

SUMMARY

The present disclosure relates to an in-vehicle navigation apparatus and a server apparatus each including a charging point register that registers charging points of vehicles in a map data storage unit.

In some systems, a charge point registering apparatus or point registering apparatus has charging points (which may also be referred to as charge points or charging stands) that are registered in the map database of its own vehicle such that the charging points are limitedly used by the own vehicle (for example, the vehicle of which the point registering apparatus is a part). To improve on this, the subject matter disclosed herein includes a new in-vehicle navigation apparatus and a new server apparatus capable of allowing other vehicles to use charging points where its own vehicle is charged while avoiding use of private charging points including private houses by the other vehicles.

According to an embodiment of the present disclosure, an in-vehicle navigation apparatus includes a map data storage unit configured to store map data; a current position detecting unit configured to detect a current position of its own vehicle; a charging point determining unit configured to determine whether the current position detected by the current position detecting unit is a charging point on the basis of charge information on the own vehicle; a charging point registering unit configured to register the charging point determined by the current position detecting unit and a charging point received from an external server apparatus in the map data storage unit; a transmission necessity determining unit configured to determine necessity for transmission of the charging point determined by the charging point determining unit to the server apparatus; and a communicating unit configured to transmit the charging point determined to have the necessity for transmission by the transmission necessity determining unit to the server apparatus and receive a charging point from the server apparatus. The transmission necessity determining unit determines the presence of public availability of the charging point by referring to the map data and determines that the charging point having the public availability has the necessity for transmission.

In the in-vehicle navigation apparatus, if the current position is determined to be a charging point on the basis of the charge information on its own vehicle, it may be determined whether the charging point has public availability by referring to the map data. The charging point determined to have public availability may be transmitted to the server apparatus and the charging point determined not to have public availability is not transmitted to the server apparatus. Accordingly, it might be possible to avoid use of the private charging points including personal houses by other vehicles.

According to another embodiment of the present disclosure, a server apparatus includes a map data storage unit configured to store map data; a communicating unit configured to receive a charging point from an in-vehicle navigation apparatus and transmit a charging point to the in-vehicle navigation apparatus; a registration necessity determining unit configured to determine necessity for registration of the charging point received from the in-vehicle navigation apparatus in the map data storage unit; and a charging point registering unit configured to register the charging point determined to have the necessity for registration by the registration necessity determining unit in the map data storage unit. The registration necessity determining unit determines the presence of public availability of the charging point by referring to the map data and determines that the charging point having public availability has a necessity for registration.

In the server apparatus, the registration necessity determining unit may determine whether the charging point received from the in-vehicle navigation apparatus has necessity for registration in the map data storage unit on the basis of the presence of public availability of the charging point determined by referring to the map data. Accordingly, it might be possible for its own vehicle to use the charging points where other vehicles are charged and which has the public availability while avoiding use of the private charging points including personal houses by the other vehicles.

In the in-vehicle navigation apparatus, the map data in the map data storage unit may include facility information, and the transmission necessity determining unit may refer to the

facility information in the map data to determine that the charging point has public availability if a facility exists near the charging point.

The transmission necessity determining unit in the in-vehicle navigation apparatus may refer to the facility information in the map data to determine that the charging point has public availability if a facility exists near the charging point. Accordingly, it might be possible for its own vehicle to use the charging points, near which facilities exist, which has public availability, and where other vehicles are charged, while avoiding use of private charging points including personal houses, near which no facility exists and which has no public availability, by the other vehicles.

In the server apparatus, the map data in the map data storage unit may include facility information, and the registration necessity determining unit may refer to the facility information in the map data to determine that the charging point has public availability if a facility exists near the charging point.

The registration necessity determining unit in the server apparatus may refer to the facility information in the map data to determine that the charging point has public availability if a facility exists near the charging point. Accordingly, it might be possible for its own vehicle to use the charging points, near which facilities exist, which has public availability, and where other vehicles are charged, while avoiding use of private charging points including personal houses, near which no facility exists and which has no public availability, by the other vehicles.

In the above embodiments, the charging point may be a point for electrically charging an electric vehicle. A charging point registering unit may refer to facility information in map data to determine that a current position is a public charging point if a facility does exists near the charging point and otherwise determine the current position is a private charging point. A charging point registering unit may register public charging points in a registry of public charging points and separately register private charging points in a registry of private charging points.

A charging point determining unit may be configured to compare a current state of charge of the vehicle with a previous state of charge of a vehicle to determine that a current position is a charging point if the current state of charge is greater than the previous state of charge by at least a certain threshold. A charging point determining unit may be configured to determine a charging rate of a charging point by comparing a current state of charge with a previous state of charge and taking into account time passed between the current state of charge and the previous state of charge. A server might not register private charging points.

Embodiments of the present disclosure may include computer program products that include one or more instructions to cause one or more processors to perform operations. The operations may include detecting a current position of a vehicle, determining whether the current position is a fueling point on the basis of fueling information of the vehicle, registering the current position as a fueling point in a fueling point register associated with map data if the current position is determined to be a fueling point, and transmitting the current position to a server computer if the current position is determined to be a fueling point.

Determining whether a current position is a fueling point may include determining whether the vehicle has had an increase in fuel, and determining that if the vehicle has had an increase in fuel the current position is a fueling point.

Determining whether a current position is a fueling point may include determining whether the current position is a public fueling point. Determining whether a current position is a public fueling point may include referencing map data to determine if the current location is a public location, and determining that if the current position is a public location and the vehicle is at a fueling point that the current position is a public fueling point.

Registering a current position as a fueling point in a fueling point register associated with map data may include registering the current position in a table of public fueling points if the current position is a public fueling point and registering the current position in a table of private fueling points if the current position is a private fueling point. Fueling points received from a server computer may be registered (e.g., in an in-car navigation system).

Determining whether a current position is a public fueling point may include determining a current position is a public fueling point if a facility exists near the current position. Determining a fueling rate of a fueling point may be performed by comparing a current state of fuel with a previous state of fuel and taking into account time passed between the current state of fuel and the previous state of fuel.

According to the present disclosure, it is possible to allow other vehicles to use charging points, where its own vehicle is charged and which has public availability, while avoiding use of private charging points, such as private houses, by the other vehicles.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** schematically illustrates a navigation system including an in-vehicle navigation apparatus.

FIG. **2** is a block diagram illustrating an example of a detailed configuration of the navigation system illustrated in FIG. **1**.

FIG. **3** is a first flowchart illustrating an operational process performed by the in-vehicle navigation apparatus illustrated in FIG. **2**.

FIG. **4** is a second flowchart illustrating the operational process performed by the in-vehicle navigation apparatus illustrated in FIG. **2**.

FIG. **5** is a third flowchart illustrating the operational process performed by the in-vehicle navigation apparatus illustrated in FIG. **2**.

FIG. **6** is a fourth flowchart illustrating the operational process performed by the in-vehicle navigation apparatus illustrated in FIG. **2**.

FIG. **7** schematically illustrates a navigation system including a server apparatus according to another embodiment.

FIG. **8** is a block diagram illustrating an example of a detailed configuration of the navigation system illustrated in FIG. **7**.

FIG. **9** is a flowchart illustrating an operational process performed by an in-vehicle navigation apparatus illustrated in FIG. **8**.

FIG. **10** is a flowchart illustrating an operational process performed by the server apparatus illustrated in FIG. **8**.

DETAILED DESCRIPTION

In-vehicle navigation apparatuses and server apparatuses according to embodiments of the present disclosure will be described with reference to the attached drawings.

FIG. **1** schematically illustrates a navigation system **10** including a server apparatus **12** and an in-vehicle navigation

apparatus (hereinafter also referred to as a navigation apparatus) **18** according to an embodiment of the present disclosure.

The navigation system **10** includes the server apparatus **12** provided in an information center **14** and the respective navigation apparatuses **18** mounted in multiple electric vehicles **16**. As used herein, an electric vehicle may be a vehicle whose power is solely provided by batteries, a plug-in hybrid electric vehicle (e.g., a hybrid vehicle using a combination of a gasoline engine, diesel engine or other fossil-fuel based engine, and an electric motor to provide power to the powertrain of a vehicle), a plug-in fuel cell vehicle, or any other vehicle having the ability to have a power source charged electrically.

In the navigation system **10**, for example, map data may be distributed from the server apparatus **12** to the navigation apparatuses **18** in the electric vehicles **16**, and traveling data about the electric vehicles **16** may be provided to the server apparatus **12**. For example, information about streets and points of interest may be sent from the server apparatus **12** to the navigation apparatuses **18**. As another example, traveling data about each electric vehicle **16** may be transmitted to the server apparatus **12** where the data is subjected to statistical processing and traffic information, such as traffic jam information, is used among the electric vehicles **16** having the navigation apparatuses **18** mounted therein. The information center **14** communicates with each electric vehicle **16** over, for example, a mobile communication network, such as a CDMA (Code Division Multiple Access)-based network.

The electric vehicles **16** include plug-in hybrid vehicles, so-called PHV or PHEV automobiles, which receive supply of the electric power from in-vehicle batteries to drive with the power from electric motors and auxiliary power from engines (not shown), in addition to the battery electric vehicles (EVs), which receive supply of the electric power from in-vehicle batteries to drive with the power from electric motors (not shown).

FIG. **2** is a block diagram illustrating an example of a detailed configuration of the navigation system **10** including the in-vehicle navigation apparatus **18**.

In the navigation system **10**, the server apparatus **12** includes a map data storage unit **20** storing map data including a road map and a control unit **22**.

The control unit **22** in the server apparatus **12** includes, for example, a microcomputer and a digital signal processor (DSP) and also operates as a function realizing unit in which a central processing unit (CPU) executes programs stored in a memory, such as a read only memory (ROM), on the basis of various inputs to realize various functions. In the present embodiment, the control unit **22** functions as, for example, a charging point register **26**, a charging point distributor **28**, and a communicator **30** described in detail below.

The navigation apparatus **18** in the navigation system **10** includes a map data storage unit **32** that stores map data including a road map, a global positioning system (GPS) unit **34** (a current-position detecting unit) that detects the current position (latitude and longitude information) of the electric vehicle **16** (its own vehicle), and a control unit (a navigation electronic control unit (ECU)) **36**.

The navigation ECU **36** includes, for example, a microcomputer and a DSP and also operates as a function realizing unit in which a CPU executes programs stored in a memory, such as a ROM, on the basis of various inputs to realize various functions. In the present embodiment, the navigation ECU **36** functions as, for example, a charging point determiner **38**, a charging point register **40**, a transmission necessity determiner **42**, and a communicator **44** described in detail below.

In addition to the GPS unit **34** and the charging point register **40**, a main switch **46**, a speed sensor **48**, a battery monitor **50**, a calendar-clock **52** (a year-month-date-time generator), and the map data storage unit **32** are connected to the charging point determiner **38**.

The main switch **46** may be an ignition switch of a vehicle. In response to an operation to turn on the main switch **46**, the battery **100** is capable of supplying power to an electric motor (not shown) and the electric vehicle **16** is in a ready-to-travel state or in a traveling state. In response to an operation to turn off the main switch **46**, the supply of power from the battery to the electric motor is blocked and the electric vehicle **16** is in a stop state.

When the main switch **46** is turned off, the battery monitor **50** sets a state in which the charging is available. During the charge available state, a charge plug (not shown) of the electric vehicle **16** is inserted into an outlet of a charging stand in order to charge the battery.

The speed sensor **48** detects the speed of the electric vehicle **16**. The battery monitor **50** is provided between the on-vehicle load, including the electric motor, and the battery **100**. The battery monitor **50** has known functions including calculation of the amount of consumption and the remaining electric charge (SOC or "state of charge") in the battery **100** and detection of the amount of full charge in the battery **100** when the charge plug is inserted into an outlet of a charging stand and the battery **100** is charged.

The calendar-clock **52** generates data about a year, month, date, and time.

The map data storage unit **32** has facility information (which may also be referred to as point of interest information) recorded thereon, in addition to road map data including the location of the house of a user, such as a driver, which has been registered in advance by the user. In the present embodiment, the facility information includes information indicating the genres, names, and position information (latitude and longitude information) of public facilities, such as parking areas and service areas on expressways, parking spaces of city and town offices, parking spaces of public gymnasiums, parking spaces of parks, parking spaces of auto supply stores, service stations, parking spaces of shopping centers, parking spaces of shopping malls, parking spaces of drug stores, and automatic parking spaces.

In addition, a genre of "charging stand" may be part of the facility information. Charging stands may be categorized into (or, have the types of) private charging stands (also referred to as personal charging stands) located at, for example, house of a user or houses of friends of the users, which have no public nature (or, in other words, no public availability), and public charging stands, such as the parking areas and the service areas on expressways, which have public availability. Charging stands may also have information indicating a type of charging stand, such as a rapid charging type charging stand, a 200-volt charging stand (200 V), and a 100-volt charging stand (100 V). Alternative charging types may exist and such types may vary depending on an electricity system used by a region or types of charging equipment used by a local market. For example, in the United States, the charging types may include rapid charging stands that charge at 480 volts, 240 volt charging stands, and 120 volt charging stands.

The map data storage unit **32** stores, as the facility information, a private charging stand table (also referred to as a personal charging stand table) **56**, which is a list of private charging stands, and a public charging stand table **58**, which is a list of public charging stands. The private charging stand table **56** and the public charging stand table **58** are updated with new information in a manner described below. The posi-

tions of houses of users might not be included in the private charging stand table **56**. This may be due to the owners or the likes of the electric vehicles **16** recognizing that they have the charging stands at their houses, such that it would be unnecessary to include their house as part of the private charging table **56**. In some implementations, the position of houses of a user may be included in the private charging stand table **56**.

The map data storage unit **20** in the server apparatus **12** stores a public charging stand table **60**, which is updated with new information.

Operations of the in-vehicle navigation apparatus **18** according to the present embodiment, which may have the above configuration, will now be described in detail with reference to flowcharts involved in the navigation apparatus **18** in FIGS. **3** to **6**.

Referring to FIG. **3**, in Step **51**, the charging point determiner **38** monitors turning-off of the main switch **46**. If the charging point determiner **38** detects that the main switch **46** is turned off (YES in Step S**1**), in Step S**2**, the charging point determiner **38** stores the current position (which may be indicated by latitude and longitude) detected by the GPS unit **34** in association with the current remaining electric charge detected by the battery monitor **50** in a memory (also referred to as a storage unit). The current position stored in the memory is called a stored current position and the current remaining electric charge stored in the memory is called a stored remaining electric charge. In Step S**3**, the charging point determiner **38** refers to the calendar-clock **52** to store the year, month, date, and time at the storage in association with the stored remaining electric charge and the stored current position.

Referring to FIG. **4**, in Step S**11**, the charging point determiner **38** monitors turning-on of the main switch **46**. If the charging point determiner **38** detects that the main switch **46** is turned on (YES in Step S**11**), in Step S**12**, the charging point determiner **38** detects the current position (latitude and longitude) from the GPS unit **34** and determines whether the current position when the main switch **46** is turned on coincides with the stored current position when the main switch **46** is turned off in Step S**1**.

If the current position when the main switch **46** is turned on coincides with the stored current position when the main switch **46** is turned off in Step S**1** (YES in Step S**12**), in Step S**13**, the charging point determiner **38** determines whether the difference resulting from subtraction of the stored remaining electric charge from the current remaining electric charge is larger than an amount-of-charge threshold value on the basis of the stored remaining electric charge and the current remaining electric charge detected by the battery monitor **50**. The amount-of-charge threshold value is used to determine whether the battery **100** is charged while the main switch **46** is turned off

If the above difference, that is, the current amount of charge is larger than the amount-of-charge threshold value (YES in Step S**13**), the charging point determiner **38** stores the current position detected in Step S**12** in the memory as a charging point registration candidate position (a charging point candidate position). In other words, the charging point determiner **38** stores the current position in the memory as the charging point registration candidate position after the charging point determiner **38** confirms that the position of the electric vehicle **16** is not varied (YES in Step S**12**) and that the battery **100** is charged (YES in Step S**13**) when the main switch **46** is turned on (YES in Step S**11**).

In Step S**14**, the charging point determiner **38** determines whether the charging point registration candidate position is registered (stored) in the private charging stand table **56** or the public charging stand table **58** in the map data storage unit **32**, that is, is registered as a charging point.

If the charging point registration candidate position is not registered as a charging point (NO in Step S**14**), in Step S**15**, the charging point determiner **38** performs a process of identifying the type of a charger involved in the charge.

FIG. **5** is a flowchart illustrating in detail the process of identifying the type of the charger, performed by the charging point determiner **38** in Step S**15**.

In Step S**15***a*, the charging point determiner **38** calculates a charge speed referred to as [Ah/h], which may be the amount of charge per unit time, according to Equation (1):

$$\text{Charge speed} = (\text{current remaining electric charge} - \text{stored remaining electric charge}) / (\text{current time} - \text{time at storage}) \quad (1)$$

In Step S**15***b*, the charging point determiner **38** determines that the charger type at the charging point registration candidate position is a rapid charger if the charge speed [Ah/h] is higher than a certain charge speed threshold value and determines that the charger type at the charging point registration candidate position is a 200-V normal charger or a 100-V normal charger on the basis of the voltage applied to the charge plug if the charge speed [Ah/h] is not higher than the certain charge speed threshold value. The charging point determiner **38** stores the result of the determination in the memory.

Referring back to FIG. **4**, in Step S**16**, the charging point register **40** registers (stores) the charging point registration candidate position involved in the combination of the charger type stored in the memory and the current position of the charging stand in the private charging stand table **56** or the public charging stand table **58** on the basis of the result of a process of determining the necessity for uploading (which may also be referred to as a process of determining the necessity for transmission to the server apparatus **12**) performed in the transmission necessity determiner **42** described in a detailed flowchart in Step S**16**.

FIG. **6** is a flowchart illustrating in detail the process of registering the charging point in Step S**16**.

In the process of determining the necessity for uploading, specifically, in Step S**16***a*, the transmission necessity determiner **42** determines whether the charging point registration candidate position involved in the combination of the charger type stored in the memory and the current position of the charging stand has public availability.

The presence of public availability is determined by referring to the map data storage unit **32** on the basis of the current position in the combination of the charger type stored in the memory and the current position of the charging stand (the charging point registration candidate position) to determine whether facility information (for example, the information about the parking areas and the service areas on expressways) exists near the current position (including the current position). If facility information does not exist near the current position (NO in Step S**16***a*), in Step S**16***b*, the charging point register **40** determines that the charging point registration candidate position indicates the position of a charging stand that is only personally or privately available, such as the house of a friend or an acquaintance of the user, and registers (stores) the charging point registration candidate position in the private charging stand table **56**. In variations, the determination may be made as to whether facility information indicates a public facility exists near the current position rather than any facility information. For example, some facility information may indicate a private location while other facility information may indicate a public location. Following

that example, a private road or series of private roads near a current position may indicate that a current location is representative of a private charging stand location. As another example, a restricted area, such as a military base may indicate a location is not available to the general public and therefore not public in the sense that it should be part of the public charging stand table.

If facility information exists near the current position, the transmission necessity determiner **42** determines in Step S**16***a* that the charging point registration candidate position has public availability (YES in Step S**16***a*) and, in Step S**16***c*, the charging point register **40** registers the charging point registration candidate position in the public charging stand table **58** as a charging point having public availability.

In Step S**16***d*, the communicator **44** uploads the registered charging point having public availability.

Specifically, in the uploading in Step S**16***d*, the transmission necessity determiner **42** transmits the charging point that is registered in the public charging stand table **58** and that has public availability to the server apparatus **12** via the communicator **44**.

The charging point register **26** in the server apparatus **12**, which receives the charging point having public availability via the communicator **30** in the server apparatus **12**, registers (stores) the charging point having public availability in the public charging stand table **60** in the map data storage unit **20**.

Since the uploading in Step S**16***d* is a process of transmitting data from the communicator **44** in the navigation apparatus **18** to the communicator **30** in the server apparatus **12** via a mobile communication network (not shown), a communication cost generally occurs. Accordingly, in some implementations, it might be desirable in terms cost that a registration of a current position (the charging point registration candidate position) in the server apparatus **12** as a charging point in Step S**16** (refer to FIG. **4**) be performed in conjunction with acquisition of traffic information or the like from the server apparatus **12**.

The charging point distributor **28** in the server apparatus **12** distributes the charging point (position data about the charging stand with the charger type and a mark indicating the charging stand) in the public charging stand table **60** to the electric vehicle **16** via the communicator **30** when a new charging point having the public availability is registered in the public charging stand table **60** or when a request to distribute the charging points having public availability is submitted from the navigation apparatus **18** in the electric vehicle **16**.

As described above, when the charging point determiner **38** determines that the current position is a charging point on the basis of the charge information about the electric vehicle **16**, the in-vehicle navigation apparatus **18** according to the present embodiment determines whether the charging point has public availability by referring to the facility information (facility position) in the map data stored in the map data storage unit **32**. As the result of the determination, since the in-vehicle navigation apparatus **18** transmits the charging point having public availability to the server apparatus **12** and does not transmit the charging point having no public availability to the server apparatus **12**, it may be possible to avoid use of the private charging points including personal houses by other vehicles.

In addition, since the transmission necessity determiner **42** in the navigation apparatus **18** refers to the facility information in the map data stored in the map data storage unit **32** to determine that the charging point has public availability if a facility exists near the charging point, it may be possible for the electric vehicle **16** to use the charging points where other vehicles are charged and which have public availability while avoiding use of the private charging points such as personal houses of other vehicles.

As described above, the facility information includes information about, for example, parking areas and service areas on expressways, parking spaces of city and town offices, parking spaces of public gymnasiums, parking spaces of parks, parking spaces of auto supply stores, service stations, parking spaces of shopping centers, parking spaces of shopping malls, parking spaces of drug stores, and automatic parking spaces.

A server apparatus according to another embodiment of the present disclosure will now be described. The same reference numerals are used in the drawings described below to identify the same components illustrated in the navigation system **10** described above for convenience, and a detailed description of such components is omitted herein. An alphabet "A" is added to reference numerals denoting components similar to the ones in the navigation system **10** described above, and such components having the alphabet "A" are described in a non-redundant manner.

FIG. **7** schematically illustrates a navigation system **10**A including a navigation apparatus **18**A and a server apparatus **12**A.

FIG. **8** is a block diagram illustrating an example of a detailed configuration of the navigation system **10**A including the server apparatus **12**A. The navigation apparatus **18**A in the example in FIG. **8** differs from the navigation apparatus **18** in FIG. **2** in that the navigation apparatus **18**A includes a navigation ECU **36**A that does not include the transmission necessity determiner **42**. The server apparatus **12**A in FIG. **8** differs from the server apparatus **12** in FIG. **2** in that the server apparatus **12**A includes a control unit **22**A having a registration necessity determiner **24** added thereto.

As illustrated in a simplified flowchart in FIG. **9**, operations in Steps S**1** to S**3** and Steps S**11** to S**15** in the navigation apparatus **18**A are the same as the operations in the navigation apparatus **18**.

Briefly, if the main switch **46** is turned off (YES in Step S**1**), in Steps S**2** and S**3**, the navigation ECU **36**A stores the current position and the current remaining electric charge in the memory in association with the year, month, date, and time.

If the main switch **46** is turned on (YES in Step S**11**) and the current position when the main switch **46** is turned on coincides with the current position when the main switch **46** is turned off (YES in Step S**12**), the navigation ECU **36**A determines whether the battery **100** is charged on the basis of the remaining electric charge when the main switch **46** is turned off and the current remaining electric charge. If the current amount of charge is larger than the amount-of-charge threshold value (YES in Step S**13**), the navigation ECU **36**A stores the current position when the main switch **46** is turned on in the memory as a charging point registration candidate position.

If the charging point registration candidate position is not registered (stored) in the private charging stand table **56** or the public charging stand table **58** in the map data storage unit **32**, that is, the charging point registration candidate position is not registered as a charging point (NO in Step S**14**), the navigation ECU **36**A performs the identification of the charger type involved in the current charge (Step S**15**), determines the charger type: for example, rapid charger, 200-V normal charger, or 100-V normal charger, and stores the determined charger type in the memory.

In Step S**21**, the charging point register **40** in the navigation ECU **36**A transmits the charging point registration candidate position with the charging stand type stored in the memory to the server apparatus **12**A via the communicator **44**.

FIG. **10** is a flowchart illustrating an example of an operation in the server apparatus **12**A according to the present embodiment.

Referring to FIG. **10**, in Step S**31**, the registration necessity determiner **24** in the server apparatus **12**A determines whether information about the same charging point with the charging stand type is transmitted (uploaded) from the multiple navigation apparatuses **18**A (the electric vehicles **16**A). If the determination in Step S**31** is affirmative (YES in Step S**31**), in Step S**32**, the registration necessity determiner **24** determines whether the charging point with the charging stand type has public availability.

Also in this case, the presence of public availability is determined by referring to the map data storage unit **32** for the charging point with the charging stand type to determine whether facility information (for example, the information about the parking areas and the service areas on expressways) exists near the current position (including the current position). If facility information exists near the current position, the registration necessity determiner **24** determines that the charging point with the charging stand type has public availability (YES in Step S**32**). In Step S**33**, the charging point register **26** registers the charging point with the charging stand type in the public charging stand table **60** as a charging point having public availability (updates the public charging stand table **60**).

In Step S**34**, the charging point distributor **28** distributes the charging point (positional data about the charging stand with the charger type and a mark indicating the charging stand) in the public charging stand table **60** to the electric vehicle **16**A via the communicator **30** when a new charging point having public availability is registered in the public charging stand table **60** or when a request to distribute the charging points having public availability is submitted from the navigation apparatus **18**A in the electric vehicle **16**A.

The charging point register **40** registers the charging point having public availability, which is distributed from the server apparatus **12**A via the communicator **44** in the navigation apparatus **18**A in the electric vehicle **16**A, in the public charging stand table **58** of its own vehicle along with a mark (a public charging stand mark) indicating that the charging point has public availability for subsequent use.

As described above, in the server apparatus **12**A according to the present embodiment, the registration necessity determiner **24** refers to the facility information in the map data stored in the map data storage unit **20** for the charging point received from the electric vehicle **16**A, determines that the charging point has public availability if a facility exists near the charging point, registers the charging point having public availability in the public charging stand table **60**, and distributes the charging point to the navigation apparatus **18**A in the electric vehicle **16**A. Accordingly, it is possible for the electric vehicle **16**A to use the charging points where the electric vehicle **16**A is charged and which has public availability while avoiding use of the private charging points including personal houses by the electric vehicle **16**A.

The features described can be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. The apparatus can be implemented in a computer program product tangibly embodied in an information carrier, e.g., in a machine-readable storage device or otherwise in a computer-readable media, for execution by a programmable processor; and methods can be performed by a programmable processor executing a program of instructions to perform functions of the described implementations by operating on input data and generating output. The described features can be implemented advantageously in one or more computer programs that are executable on a programmable system including at least one programmable processor coupled to receive data and instructions from, and to transmit data and instructions to, a data storage system, at least one input device, and at least one output device. A computer program is a set of instructions that can be used, directly or indirectly, in a computer to perform a certain activity or bring about a certain result. A computer program can be written in any form of programming language, including compiled or interpreted languages, and it can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, or other unit suitable for use in a computing environment.

Suitable processors for the execution of a program of instructions include, by way of example, both general and special purpose microprocessors, and the sole processor or one of multiple processors of any kind of computer. Generally, a processor will receive instructions and data from a read-only memory or a random access memory or both. Elements of a computer may be a processor for executing instructions and one or more memories for storing instructions and data. A computer may also include, or be operatively coupled to communicate with, one or more mass storage devices for storing data files; such devices include magnetic disks, such as internal hard disks and removable disks (e.g., magneto-optical disks, optical disks, solid-state disks, and the like). Storage devices suitable for tangibly embodying computer program instructions and data include all forms of non-volatile memory, including by way of example semiconductor memory devices, such as EPROM (erasable programmable read only memory), EEPROM (electrically erasable programmable read only memory), and flash memory devices; magnetic disks such as internal hard disks and removable disks; magneto-optical disks; and CD-ROM (compact disc read only memory) and DVD-ROM (digital versatile disc read only memory) disks. The processor and the memory can be supplemented by, or incorporated in, ASICs (application-specific integrated circuits).

To provide for interaction with a user, the features can be implemented on a computer having a display device such as a CRT (cathode ray tube), LCD (liquid crystal display), or other type of monitor for displaying information to the user and a keyboard and a pointing device such as a mouse or a trackball by which the user can provide input to the computer. Other input devices may include a joystick-type device, a touch-screen display, hard buttons (e.g., physical buttons tied to one or more operations), and/or soft buttons (e.g., physical buttons that depend on a context in which a program is running).

The features can be implemented in a computer system that includes a back-end component, such as a data server, or that includes a middleware component, such as an application server or an Internet server, or that includes a front-end component, such as a client computer having a graphical user interface or an Internet browser, or any combination of them. The components of the system can be connected by any form or medium of digital data communication such as a communication network. Examples of communication networks include, e.g., a LAN (local area network), a WAN (wide area network), and the computers and networks forming the Internet. Communication networks may use various technologies for wired and wireless communications, such as CDMA (Code Division Multiple Access), LTE (Long Term Evolution), IEEE (Institute of Electrical and Electronics Engineers) 802.11 standards, and the like.

The computer system can include clients and servers. A client and server are generally remote from each other and typically interact through a network, such as the described

one. A server may also be referred as being "external" to a client. For example, by the server being part of a separate apparatus from a client. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. In the case of the navigation systems described above, the navigation apparatus of a vehicle may be a client to the server.

In the navigation apparatus **18** and the server apparatus **12**A according to the above embodiments, although the determination of the charging point is performed by the charging point determiner **38** in the navigation ECU **36** and the navigation ECU **36**A, the present disclosure is not limited to the above embodiments and various configurations may be realized on the basis of the content of description in this specification. For example, the current position and the remaining electric charge may be transmitted from the navigation apparatus to the server apparatus when the main switch **46** is turned off and the current position and the remaining electric charge may also be transmitted from the navigation apparatus to the server apparatus when the main switch **46** is turned on, and the server apparatus may determine whether the current position is a charging point, may determine the charger type if the current position is a charging point, and may determine whether the charging point has public availability. As another example, while the disclosure has been described with references to variations of electric charging systems for vehicles, the techniques disclosed may be relevant to other distributed and/or growing fueling systems, such hydrogen fueling, natural gas fueling, and the like. For example, new publicly available natural gas fueling stations may be uploaded to a server from a vehicle's navigation system of a natural gas vehicle and downloaded to other natural gas vehicles. As another example, while the disclosure has been described with reference to plug-in electric charging technologies, the techniques of the disclosure may be applied to other charging technologies such as inductive charging. As another example, while the process of FIG. **5** in combination with equation 1 is shown to indicate one way to determine a type of charger, there may be other ways to determine a type of charger. For example, one type of charger may identify itself through an electronic signal. As another example, based on a type of connection made with a charging device (e.g., a type of plug used), a type of charger may be determined. As another example, a type of charger may be determined by waking up the system during charging and determining a charging rate. While specific implementations of systems have been described with specific flow charts or processes, variations may use different systems and/or processes. For example, a navigation system varying from the navigation system **10** described above may be used with processes similar to the processes described with reference to FIGS. **3**-**6**.

What is claimed is:

1. An in-vehicle navigation apparatus comprising:

a map data storage unit configured to store map data, the map data comprising facility information;

a current position detecting unit configured to detect a current position of a vehicle associated with the in-vehicle navigation apparatus;

a charging point determining unit configured to determine whether the current position detected by the current position detecting unit is a charging point on the basis of charge information on the vehicle;

a charging point registering unit configured to:

register the charging point determined by the current position detecting unit, the charging point determined by the current position detecting unit as previously not registered as the charging point with the in-vehicle navigation apparatus and

register a server-sourced charging point received from a server apparatus external from the in-vehicle navigation apparatus in the map data storage unit;

a transmission necessity determining unit configured to determine necessity for transmission of the charging point determined by the charging point determining unit to the server apparatus; and

a communicating unit configured to transmit the charging point determined to have the necessity for transmission by the transmission necessity determining unit to the server apparatus and receive the server-sourced charging point from the server apparatus,

wherein the transmission necessity determining unit determines the presence of public availability of the charging point by referring to the facility information in the map data to determine that the charging point has the public availability instead of private availability if a facility exists near the charging point, and the transmission necessity determining unit determines that the charging point having the public availability has the necessity for transmission.

2. The in-vehicle navigation apparatus according to claim **1**,

wherein the transmission necessity determining unit refers to the facility information in the map data to determine that the charging point does not have the public availability if the facility does not exist near the charging point.

3. The in-vehicle navigation apparatus according to claim **1**, wherein the charging point is a point for electrically charging an electric vehicle.

4. The in-vehicle navigation apparatus according to claim **1**,

wherein the charging point registering unit refers to the facility information in the map data to determine that the current position is a public charging point if the facility does exists near the charging point and otherwise determines the current position is a private charging point, and the charging point registering unit registers public charging points in a registry of public charging points and separately registers private charging points in a registry of private charging points.

5. The in-vehicle navigation apparatus according to claim **1**,

wherein the vehicle is an electric vehicle; and

wherein the charging point determining unit is configured to compare the current state of charge of the vehicle with a previous state of charge of the vehicle to determine that a current position is the charging point if the current state of charge is greater than the previous state of charge by at least a certain threshold.

6. The in-vehicle navigation apparatus according to claim **5**,

wherein the charging point determining unit is further configured to determine a charging rate of the charging point by comparing the current state of charge with the previous state of charge and taking into account time passed between the current state of charge and the previous state of charge.

7. A computer program product embodied on computer-readable media, the media comprising computer-readable instructions, the instructions operable to cause one or more processors to perform operations comprising:

detecting a current position of a vehicle;

determining whether the current position is a fueling point on the basis of fueling information of the vehicle;

determining if the fueling point was not previously registered in a fueling point register associated with map data of the vehicle;

registering the current position as the fueling point in the fueling point register associated with the map data if the current position is determined to be the fueling point and the fueling point is determined to not have been previously registered;

determining if the fueling point is to be categorized as being public or private, wherein the fueling point is categorized as being public instead of being private if the current position is associated with a public location in map data and the current position is determined to be the fueling point; and

transmitting the current position to a server computer if the current position is determined to be categorized as being public.

8. The computer program product of claim **7**, wherein the fueling point is an electric charging point for electric vehicles.

9. The computer program product of claim **7**, wherein the operation of determining whether the current position is the fueling point comprises:

determining whether the vehicle has had an increase in fuel;

determining that if the vehicle has had an increase in fuel the current position is the fueling point.

10. The computer program product of claim **7**, wherein:

registering the current position as the fueling point in the fueling point register associated with the map data comprises:

registering the current position in a table of public fueling points if the current position is a public fueling point; and

registering the current position in a table of private fueling points if the current position is a private fueling point.

11. The computer program product of claim **7** wherein the operations further comprise:

registering fueling points received from the server computer.

12. The computer program product of claim **7**, wherein:

the vehicle is an electric vehicle; and

the operations further comprise:

comparing the current state of charge of the vehicle with a previous state of charge of the vehicle to determine that the current position is the fueling point if the current state of charge is greater than the previous state of charge by at least a certain threshold.

* * * * *